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SOME EFFECTS OF PLANT GROWTH-REGULATING SUBSTANCES ON MICROORGANISMS

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During recent years, much work has been done on the effect of various synthetic plant hormones on higher plants. This suggested that the same compounds may also have some effects on lower forms of living organisms—the bacteria, yeasts, molds, and actinomycetes.

Little work has been reported on the effects of these compounds on microorganisms. Indole acetic acid was found by Leonian and Lilly (1937) to be inhibitory to several fungi and algae. Brannon and Bartsch (1939), however, tested the effect of several of the growth regulators on *Chlorella vulgaris* and found marked stimulation when the chemicals were used in low concentrations.

Stevenson and Mitchell (1945) reported that 0.02 per cent of 2-4-dichlorophenoxy acetic acid or its sodium salt inhibited, and 0.1 per cent prevented, the growth of several species of bacteria; molds, however, were much more tolerant to the chemical. Culler (1946) in general confirmed these results and further noted greater susceptibility of gram-positive than of gram-negative bacteria.

The investigation reported in this paper was undertaken to increase our knowledge of the effects of a few plant growth-regulating substances on several bacteria and on a few molds and actinomycetes.

METHODS AND MATERIALS

Chemicals used.—The sodium salts of 2-4-dichlorophenoxy acetic acid, β-naphthoxy acetic acid, 4-chlorophenoxy acetic acid, and β-indole butyric acid were used in the experiments.

These were prepared by suspending the weighed acid in water, and titrating with N/1 NaOH using phenolphthalein as the indicator.

Serial dilutions were prepared in 0.05 molar phosphate buffer with pH 6.2. Resulting concentrations ranged from 0.00001 to 1.0 per cent.

TEST ORGANISMS

BACTERIA

Aerobacter aerogenes
Aerobacter cloacae
Bacillus subtilis
Brucella abortus
Corynebacterium diphtheriae
Escherichia coli
Sarcina lutea
Serratia indica
Serratia marcescens
Staphylococcus aureus

MOLDS

Aspergillus niger
Mucor sp.
Penicillium notatum

ACTINOMYCETES

Streptomyces griseus
Streptomyces lavendulae

Tests of growth.—Growth on plates was tested using the ratio of 90 ml. agar basal medium to 10 ml. of salt solution. Difco nutrient agar was used for *B. subtilis*, *A. cloacae*, *S. lutea*, *S. aurens*, *S. indica*, and *S. marcescens*. Tryptose-glucose agar was used to test the growth of *B. abortus*, *C. diphtheriae*, *S. aureus*, and *E. coli*. Difco malt agar was prepared for testing *P. notatum*, *A. niger*, and *Mucor* sp. Glucose-asparagine agar was used for *S. griseus* and *S. lavendulae*.

Tests for turbidity were set up as follows. Nine ml. amounts of broth were pipetted into standard 7″ x ⅞″ test tubes. To these were added 1 ml. amounts of the various dilutions of the plant growth-regulating substances. Difco nutrient broth was used as the basal medium in testing *S. lutea*, *B. subtilis*, *S. aureus*, and *E. coli*. Tryptose-glucose broth was employed in testing growth on *B. abortus*, *C. diphtheriae*, *S. aureus*, and *E. coli*.

The tubes were inoculated with 0.2 ml. of a broth suspension of the organisms and incubated at 37° C. for 90 hours. The amount of growth as shown by turbidity was determined by obtaining galvanometer readings, using an Evelyn Photoelectric colorimeter, at various time intervals throughout the incubation period. Light filter #540 was used. The photometric densities were then calculated from the galvanometer readings.

Biochemical tests.—Biochemical tests were made using nutrient gelatin, and glucose, sucrose, lactose, tryptone, and M.R.V.P. broths. These media were prepared to have final concentrations of 0.1, 0.01, and 0.001 per cent 4-chloro-phenoxy acetate, 2-4- dichlotophenoxy acetate, and β-naphthoxy acetate.

These tests were made on *E. coli*, *B. subtilis*, *A. aerogenes*, *S. aureus*, and *S. marcescens*.

Tests for development of resistance.—Nutrient broths were prepared containing concentrations of 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, and 0.09 per cent of each of the chemicals. After inoculation and incubation, the tube with the highest concentration of chemical allowing growth was selected. Transfers were made from this tube to basal nutrient broth and to broth containing the next higher concentration of the chemical. Also, after incubation of the nutrient broth culture the next higher per cent solution was inoculated from it. The procedure was continued until no growth was obtained upon repeated transfer to media containing the higher concentration of the growth regulator. This was considered the limit of the resistance acquired by the test organism.

Morphologic studies.—Gram and methylene blue stains were prepared of all bacteria from both agar plates and broth cultures. Smears were made from the broth cultures at the time of each turbidity reading in an attempt to determine if any changes in morphology occurred during the incubation period.

The molds and actinomycetes were examined only for their gross morphologic characteristics.

RESULTS

Effects on growth.—*A. cloacae* when streaked on plates of nutrient agar containing serial concentrations of 0.1 to 0.000001 per cent of the sodium salts of β-indole butyric acid, 2-4-dichlorophenoxy acetic acid and β-naphthoxy acetic acid respectively and incubated, gave good growth in all concentrations except 0.1 per cent. After incubation for four days, the latter concentration permitted almost normal growth. Under the same conditions, *B. subtilis* appeared to be greatly inhibited for 24 hours, but on continued incubation good growth was obtained except at 0.1 per cent concentrations where there was complete inhibition.

Growth of *S. lutea* was greatly retarded for five days and when growth was obtained the pigment of the organisms on the test media was much deeper than for those grown on basal medium. *S. aureus* was completely inhibited for five days by 0.1 per cent β-naphthoxy acetate; with other chemicals there was decided inhibition at 0.1 and 0.01 per cent. The growth of *S. aureus* and *S. lutea* is shown

in Table I. *S. indica* and *S. marcescens* did not appear at all affected by 0.1 nor *E. coli* by 0.2 per cent of growth-regulators.

Growth of *C. diphtheriae* and *B. abortus* also appeared retarded for a period with growth equal to that of the control being obtained upon continued incubation. Complete inhibition for three days was obtained at 0.2 and 0.1 per cent. These results are shown in Table II.

Test plates of molds were observed over a 10-day period. *P. notatum* and *Mucor* sp. were inhibited somewhat at a concentration of 0.1 per cent. There

TABLE I

THE EFFECTS OF SODIUM SALTS OF GROWTH-REGULATORS ON THE GROWTH AND PIGMENT PRODUCTION OF *S. aureus* AND *S. lutea*

MEDIUM; SALT IN PER CENT	*S. aureus*			*S. lutea*		
	1 Day	2 Days	5 Days	1 Day	2 Days	5 Days
Control	3	4	4	4	4	4
β-indole butyrate						
0.1	1	2	4	0	0	2D
0.01	1	3	4	0	2	2D
0.001	1	3	4	0	2	2D
0.0001	2	4	4	0	2	3D
0.00001	2	4	4	0	2	3D
0.000001	2	4	4	–	1	3D
2-4-dichlorophenoxy acetate						
0.1	0	0	1	0	–	–D
0.01	1	1	1	0	1	3D
0.001	2	3	4	0	1	3D
0.0001	2	3	4	0	1	4D
0.00001	2	3	4	0	1	4D
0.000001	3	3	4	0	1	4
β-naphthoxy acetate						
0.1	0	0	0	0	1	3
0.01	–	2	3	–	2	3
0.001	1	2	3	0	2	3D
0.0001	2	3	4	0	2+D	3
0.00001	2	3	4	0	2+	3D
0.000001	2	4	4	1	2+	3

D = Deeper pigment than on control.
Growth: 4 = excellent; 3 = good; 2 = fair; 1 = poor; – = a few scattered colonies; 0 = no growth.

was marked inhibition of growth and sporulation of *A. niger* at 0.1 and 0.01 per cent of the acetates.

There was significant inhibition of *S. griseus* and *S. lavendulae* at concentrations of 0.1 and 0.01 per cent of the salts tested. It was observed that the pigment of *S. lavendulae* was much lighter on all media containing the salts; at a concentration of 0.1 per cent β-naphthoxy acetate and β-indole butyrate, and at 0.01 per cent 2-4-dichlorophenoxy acetate, no pigment was observed. This indicates a decrease in sporulation, since the pigment of *S. lavendulae* is due to spores. On the control plate good pigmentation was obtained.

It was decided to attempt to determine more accurately the effect on the growth of bacteria of the chemicals under test. For this purpose the turbidities of broth cultures during incubation were determined by the use of the Evelyn photoelectric colorimeter. Growths of *S. aureus, B. subtilis, C. diphtheriae, B. abortus* and

TABLE II

THE EFFECTS OF SODIUM SALTS OF GROWTH-REGULATORS ON *C. diphtheriae* AND *B. abortus*

MEDIUM; SALT IN PER CENT	*C. diptheriae*			*B. abortus*		
	1 Day	2 Days	3 Days	1 Day	2 Days	3 Days
Control	4	4	4	1	4	4
2-4-dichlorphenoxy acetate						
0.2	0	0	0	0	0	0
0.1	0	0	0	0	0	0
0.01	2	3–	4	1	3	3
0.001	3	3	4	1	4	4
0.0001	3	4	4	1	4	4
β-naththoxy acetate						
0.2	0	0	0	0	0	0
0.1	0	0	0	0	0	0
0.01	3	3	3	1	3	3
0.001	3	3	3	1	3	4
0.0001	3	3	3	1	4	4
4-chlorophenoxy acetate						
0.2	0	0	0	0	0	0
0.1	0	0	0	0	0	0
0.01	3	3	4	1	3	3
0.001	3	3	4	1	4	4
0.0001	3	3	4	1	4	4

Growth: 4=excellent; 3=good; 2=fair; 1=poor; — a few scattered colonies; 0=no growth.

TABLE III

THE EFFECT OF SODIUM SALTS OF GROWTH-REGULATORS ON *B. subtilis* IN LIQUID MEDIA

MEDIUM; SALT IN PER CENT	PHOTOMETRIC DENSITY				
	18 Hours	24 Hours	42 Hours	66 Hours	90 Hours
Control	.0580	.0605	.1249	.1675	.1871
4-chlorophenoxy acetate					
0.2	.0132	.0177	.0177	.0177	.0177
0.1	.0132	.0132	.0132	.0132	.0132
0.01	.0304	.0315	.0505	.0757	.1427
0.001	.0177	.0177	.0667	.1135	.1487
0.0001	.0223	.0315	.0706	.1249	.1739
0.00001	.0269	.0315	.0915	.1367	.1675
2-4-dichlorophenoxy acetate					
0.2	.0044	.0044	.0044	.0044	.0044
0.1	.0044	.0044	.0066	.0088	.0088
0.01	.0223	.0315	.0505	.1024	.1549
0.001	.0315	.0410	.1024	.1337	.1580
0.0001	.0362	.0410	.1024	.1302	.1659
0.00001	.0386	.0458	.1079	.1487	.1739
β-naphthoxy acetate					
0.2	.0044	.0066	.0088	.0177	.0177
0.1	.0088	.0132	.0132	.0132	.0132
0.01	.0339	.0362	.0655	.0969	.1308
0.001	.0269	.0362	.0862	.1024	.1739
0.0001	.0315	.0362	.1051	.1534	.1739
0.00001	.0458	.0505	.1367	.1612	.1739

S. lutea were markedly inhibited by 0.1 and 0.2 per cents of the salts and progressively less by lower concentrations. Typical data are presented in Table III for *B. subtilis*.

The only instance of stimulation of growth by low concentrations of chemical was noted for *E. coli* by 4-chlorophenoxy acetate. These data are presented in Table IV.

In order to determine whether the increase in turbidity actually represented an increase in the numbers of viable cells in the media containing small amounts

TABLE IV

THE EFFECT OF 4-CHLOROPHENOXY ACETATE ON GROWTH OF *E. coli*

MEDIUM; SALT IN PER CENT	PHOTOMETRIC DENSITY			
	24 Hours	48 Hours	72 Hours	96 Hours
Control	.0757	.2076	.2182	.2255
4-chlorophenoxy acetate				
0.2	.0315	.0580	.1249	.1308
0.1	.0505	.0969	.1580	.1580
0.01	.0555	.1739	.2182	.2255
0.001	.0757	.2111	.2441	.2460
0.0001	.0706	.2147	.2403	.2480
0.00001	.0731	.2247	.2441	.2441
0.000001	.0783	.2218	.2441	.2480
0.0000001	.0783	.2218	.2441	.2499

TABLE V

CORRELATION BETWEEN PHOTOMETRIC DENSITY AND NUMBERS OF VIABLE CELLS OF *E. coli*

MEDIUM	NO. ORGANISMS PER ML.		DENSITY	
	*48 Hours	96 Hours	48 Hours	96 Hours
Control	200 M.**	370 M.	.2076	.2255
4-chlorophenoxy acetate 0.0001%	300 M.	840 M.	.2147	.2480
4-chlorophenoxy acetate 0.0000001%	500 M.	890 M.	.2218	.2499

* Incubation time of tube culture when sample was plated.
** M=million.

of 4-chlorophenoxy acetate, serial dilutions from representative tubes were made and plated in duplicate in nutrient agar. After 24 hours incubation, colony counts were made. Results showed a good correlation between numbers of organisms per ml. and photometric densities as is illustrated by Table V.

In general, turbidity determinations indicate that there is a period during which these chemicals in low concentrations inhibit growth, but that after prolonged incubation, growth equal to or nearing that in the control media is obtained. The results described above on the effect of 4-chlorophenoxy acetate on growth of *E. coli* are the exception. This was the only case in which a significant stimulation of growth was obtained.

Biochemical reactions.—The biochemical reactions of the microorganisms tested did not appear to be affected by growth in the presence of the test chemicals. There was one exception to this; *E. coli* in 0.1 per cent 4-chlorophenoxy acetate lactose broth produced acid but no gas. On transfer from the test solution to a tube of plain lactose broth, the organism formed both acid and gas as is customary for this bacterium. Reactions in the other media tested were not changed.

Development of resistance.—Three organisms were tested for ability to acquire resistance to these chemicals; they were *B. subtilis*, *S. aureus*, and *S. lutea*.

The parent strain of *B. subtilis* grew at a maximum concentration of 0.04 per cent β-naphthoxy, 4-chlorophenoxy, and 2-4-dichlorophenoxy acetates in 24 hours. Subsequent inoculations into higher percentages gave growth in 0.06 per cent but not in 0.07 per cent except with 4-chlorophenoxy acetate. It should be noted that although *B. subtilis* did not grow in 0.07 per cent solutions, growth was obtained in plain broth inoculated from tubes of this concentration which had been inoculated with the bacterium, indicating inhibitory rather than bactericidal effect of the acetates.

S. lutea grew in media containing 0.03 per cent solutions of the chemicals. Growth was obtained in 24 hours in 0.04 per cent when transferred from 0.03 per cent solutions. After four transfers through media containing 0.04 per cent acetates, growth was obtained in 0.05 per cent solutions. No growth was obtained in concentrations of 0.06 per cent.

S. aureus grew well in a concentration of 0.05 per cent of each of the three salts in 24 hours. Transfers into higher concentrations produced no growth above 0.07 per cent until the fifth day of incubation, when in tubes of 0.08 per cent acetates, growth was observed.

Morphologic studies.—Smears from both solid and liquid media showed no change in morphology or staining reaction by Gram's method. In the stains made at each turbidity reading, there was apparently no change in cell shape or grouping at any time during the incubation period. Methylene blue stains of *C. diphtheriae* showed granules on smears from control cultures and on those of organisms grown in the presence of the growth-regulators.

No change in the gross morphology of the molds and actinomycetes was noted with the exception of the apparent decrease in sporulation of *A. niger* and *S. lavendulae*.

DISCUSSION

Both streak plates and broth cultures showed that the growth of *S. aureus*, *B. subtilis*, *C. diphtheriae*, *B. abortus*, and *S. lutea* was almost completely inhibited by 0.1 per cent 4-chlorophenoxy acetate, β-naphthoxy acetate, and 2-4-dichlorophenoxy acetate. On the other hand, the gram negative bacteria, *E. coli*, *S. indica*, *S. marcescens*, and *A. cloacae* grew well in a concentration of 0.1 per cent of the salts. These findings agree with the observation that, in general, bacteriostatic agents are more inhibitory to gram positive than they are to gram negative bacteria and specifically with Culler's (1946) data for 2-4-dichlorophenoxy acetate.

In broth cultures and on streak plates, *B. subtilis*, *S. lutea*, and *S. aureus* seemed to be greatly inhibited for a period of time, but on continued incubation growth nearly equal to that of the control was obtained. Apparently, these bacteria became adapted to the chemical. Tests to determine ability to acquire resistance to the salts were performed on these three organisms, and it was found that they did adapt themselves to growth in the presence of 0.2 to 0.3 per cent increase in the amounts of the acetates.

Many investigators have reported stimulation of growth of higher plants by the chemicals used in this investigation. The only case of apparent stimulation which we observed was that produced with *E. coli* by 4-chlorophenoxy acetate in

concentrations of 0.0001 per cent and lower. Here a significant increase in number of organisms was confirmed by plate counts and by turbidity determinations. Perhaps, extremely low concentrations of the other chemicals might stimulate growth of this and other organisms but no evidence was obtained to support this.

Changes in biochemical reactions were not observed except in one case. When *E. coli* was grown in lactose broth with 0.1 per cent 4-chlorophenoxy acetate added, acid but no gas was produced. Since hydrogenlyase is responsible for the production of gas from formic acid in the dissimilation of carbohydrate by *E. coli*, this enzyme may be inhibited in the presence of the growth-regulator. However, with this one exception, no evidence was obtained for the inhibition of specific enzyme activity.

It can be seen that the results obtained with 2-4-dichlorophenoxy acetate in this investigation correlate well with those found by other workers. Little has been published on the effects of the other growth-regulators on bacterial growth.

SUMMARY

Sodium salts of β-indole butyric acid, 4-chlorophenoxy acetic acid, 2-4-dichlorophenoxy acetic acid and β-naphthoxy acetic acid, when incorporated in media, were inhibitory to the growth of several gram positive bacteria in concentrations higher than 0.01 per cent. Gram negative bacteria were less readily inhibited.

Aspergillus niger and *Streptomyces lavendulae* were inhibited by 0.1 per cent of the salts and sporulation was markedly decreased by as little as 0.01 per cent.

A limited increase in resistance to the growth-regulating substances by *Bacillus subtilis*, *Staphylococcus aureus*, and *Sarcina lutea* was obtained by culturing the bacteria in increasing concentrations of the chemicals incorporated in media.

The only instance of stimulation of growth was noted for *Escherichia coli* when grown in the presence of 4-chlorophenoxy acetate in concentrations of 0.0001 per cent or lower.

No changes in morphologic characteristics or staining reactions, as a result of growth in the presence of the chemicals, were noted.

The only alteration in biochemical reaction observed was the failure of *Escherichia coli* to produce gas when grown in lactose broth containing 4-chlorophenoxy acetate.

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SOME FEATURES OF THE TRIBUTARIES TO LAKE SUPERIOR IN NORTHEASTERN MINNESOTA

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More than thirty streams, extending from Duluth to the Pigeon River, along the north shore of Lake Superior, flow from the upland into this lake. Many of these have falls and rapids in their lower courses. They either rise in glacial lakes or marshes or flow through them, having broad, boulder-strewn channels but at a comparatively short distance from the lake, their gradients are steep. Here they cut deep, narrow gorges through the basalt flows, diabase dikes and sills of Keweenawan age. The streams have taken advantage of the vertical jointing and the weaker amygdaloidal zones in excavating their channels. Numerous well-developed potholes are found along the courses of some of the streams. The waterfalls and cascades are of exceptional beauty.

The rejuvenation of the streams which is responsible for the gorges, is attributed to the gradual lowering of the glacial lake levels as new outlets were opened by the recession of the Lake Superior ice-lobe, the post-glacial tilting of the land, and the deepening and widening of the Lake Superior trough by the glacier.

DESCRIPTION AND BASIC FACTS

Along the north shore of Lake Superior, the hills are close to the shoreline and cascades and waterfalls are present on many streams near their outlet. There are more than thirty rushing, tumbling streams between Duluth and the Canadian border, some of which descend as much as a thousand feet or more in their short courses to Lake Superior. The interstream divides rise to 400 feet and in some places nearly a thousand feet within a distance of a mile from the lake. There are numerous lakes at the headwaters of these streams which serve as storage reservoirs and supply a constant flow during dry seasons which adds to their value as future sources of water power.

The principal streams, named in order from Duluth to the international boundary are the Lester, Gooseberry, Beaver Bay, Baptism (Fig. 2), Manitou (Fig. 3), Cross, Temperance, Poplar, Cascade, Devil's Track, Brule and Pigeon rivers. None are large streams and their drainage areas are comparatively small. The largest is the Pigeon River (Fig. 4), which has a drainage of 628 square miles. The others, in order of size, have the following drainage areas:[2] Brule, 282 sq. mi.; Temperance, 198 sq. mi.; Poplar, 144 sq. mi.; Baptism, 135 sq. mi.; Beaver Bay, 120 sq. mi.; Gooseberry, 85 sq. mi.; Cascade, 84 sq. mi.; Devil's Track, 75 sq. mi.; Manitou, 71 sq. mi.; Lester, 55 sq. mi., and Cross, 32 sq. mi

The streams tributary to Lake Superior on the north shore flow from the upland with gradients averaging 250 feet in a distance of about one and one-half miles. The rapids and falls begin at points as close to Lake Superior as .05 mile, up to points greater than a mile. The altitude of their courses on the glaciated upland varies from 1650 to 1950 feet, averaging 1800 feet. In general, the minor tributaries on the north shore of Lake Superior have a rapid fall from source to mouth except for short distances through lakes or swamps. When traced from their outlets at Lake Superior to their sources, the general sequence of features is as follows: at the junction of the river and the lake there is usually a gravel bar

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[2]Leverett, Frank. Moraines and Shorelines of the Lake Superior Basin. U. S. Geol. Survey, Professional Paper 154, p. 11.

thrown across the mouth by the vigorous waves from the lake. Because of the absence of a bar at its mouth, the Temperance River was given its unique name. Behind the bars there may be a gentle gradient with rather quiet water for a short distance. In some instances, the falls and rapids begin not far back from the shoreline. For a distance of a mile, more or less, the streams flow through narrow gorges, leaping from ledge to ledge by cascades and waterfalls. Beyond the falls and rapids on the upland, the streams open into wide, flat-bottomed, boulder-strewn channels. Their courses on the upland do not appear to follow any definite preglacial channels and wind about through lakes and swamps, following the lines of least resistance. This condition is characteristic of immature drainage in glaciated regions.

The small tributaries to Lake Superior on the north shore, in Minnesota, are associated with some of the finest scenery in the north country. They pass through coniferous forests in deep, narrow, angular, vertically-walled gorges through which the water leaps from pothole to pothole by a series of falls or rapids. They are, in many instances, easily accessible from the highway by trails constructed by the State Highway Department.

Perhaps the most spectacular of the falls are those on the Pigeon, Manitou (Fig. 3), Temperance, Cascade, Devil's Track (Fig. 6), Brule, Gooseberry and Cross rivers. The Pigeon River has the highest falls (Fig. 4), 120 feet, and a narrow spectacular gorge in its lower course. The Temperance River is unique for its extremely narrow gorge which is less than ten feet wide in places and 50 to 75 feet deep. The thunder of the water as it passes from ledge to ledge, through openings not more than three feet wide, is awe-inspiring.

One of the most interesting features in the gorges of some of these streams is the well-developed potholes. In the courses of the Temperance and Cascade rivers these potholes are especially well displayed (Fig. 5). In the opinion of the writer, there are few places in the country where one can see a finer display of potholes. Cut out of the solid rock, their sides are smoothly polished. The gorges of the Temperance and Cascade rivers, for long distances, consist of a series of potholes, some large and others small. These streams flow through a forested region and their waters carry little material in suspension. The sediment is made up of gravel, cobblestones and boulders, mainly of glacial origin, which makes excellent material for grinding potholes in solid rock. In a number of instances, the writer found potholes from 6 inches to a foot or more in diameter, cut down vertically in the diabase for depths of two to three feet. So perfect are they that they appear to have been cut by a drill. The pebbles which served as grinding tools are still present in some of them. In some cases, the potholes are huge, being as much as 25 feet in diameter and shaped like a jug. The junction between potholes is frequently sharp and triangular in outline. At one spot in the falls of the Brule (Arrowhead) River, a large part of the water dashes down into a pothole or circular pit about 8 to 10 feet in diameter, known as the "Devil's Kettle." The water disappears from view and the place where it makes its reappearance at the surface is not visible. Hence, the belief that the pit is bottomless and has no outlet. The water probably finds an outlet to the main channel by a subterranean course, not visible at the surface. Above the gorge of the Temperance River there is evidence that the water flowed originally in a broader channel. A deep abandoned pothole occurs along the trail not far from the edge of the gorge, indicating that the stream at higher levels abandoned its course in places and sought new less resistant avenues of escape as it cut downward.

The conditions for the formation of the narrow angular gorges and potholes are ideal. The Keweenawan flows have amygdaloidal zones which are weaker and less resistant sedimentaries occur interstratified with the flows. The diabase

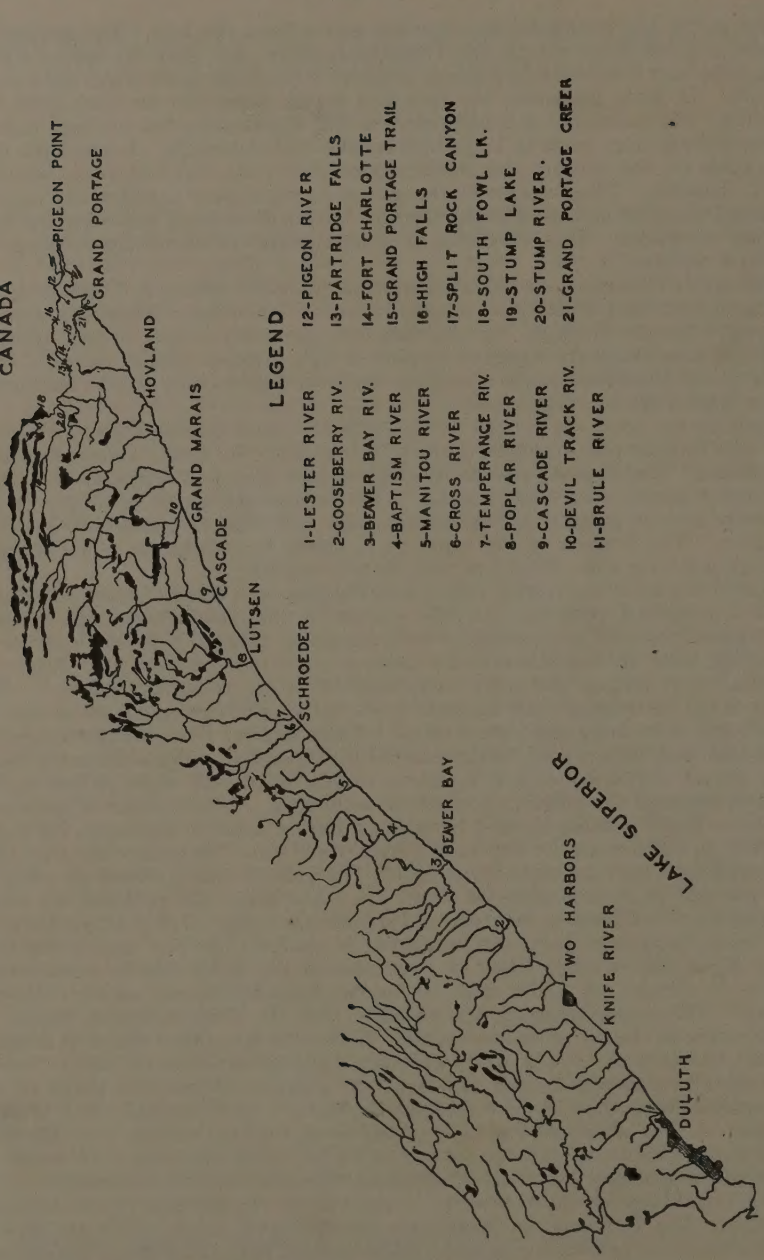

FIG. 1. A map showing some features of the tributaries to Lake Superior in northeastern Minnesota.

FIG. 2. Falls of the Baptism River.

FIG. 3. Manitou Falls on Manitou River.

FIG. 4. High Fall on Pigeon River.

FIG. 5. Cascade Falls on Cascade River.

FIG. 6. Devil Track Fall on Devil Track River.

dikes and sills have well developed vertical jointing along which the streams have cut their channels.

EFFECTS OF GLACIATION

In preglacial time the drainage lines were oriented in a general northeast-southwest direction, the result of the monoclinal ridge and valley topography of the area. No doubt, the drainage in northeastern Minnesota was quite different from that of today. It is probable that the body of water now known as Lake Superior did not exist in preglacial time. It is more likely that its present site was a broad lowland occupied by a river system. Before the ice-age, the streams in the area occupied broad open valleys of low gradient, such as characterize a region in an advanced stage in the cycle of erosion. The advent of the ice-sheets changed that condition; old streams were obliterated; others were forced to take new courses and entirely new streams came into being. Numerous lakes and swamps are now present where none existed before.

Many of the youthful post-glacial streams have cut deep, narrow gorges having numerous waterfalls and rapids. One cannot but be impressed by the size and depth of some of these post-glacial gorges. It may be that the enormous volume of melt-water from the shrinking ice-sheets was responsible for the rapid erosion necessary to produce gorges of such width and depth.

The Pigeon River has a comparatively low gradient in its lower course, as compared with the slopes of the smaller streams along the north shore of Lake Superior. This is accounted for by the fact that the Pigeon River is located principally on the Rove Slate which is weaker than the Keweenawan flows and intrusives. Pigeon River has an average gradient of 28 feet per mile in a distance of 30 miles. For a distance of one and one-half miles from its mouth, it has eroded its channel down to the level of Lake Superior, whereas the other streams tributary to the lake descend over rock ledges to points within short distances of the shoreline.

From a point above Partridge Falls about 20 miles from its outlet to one about 1.7 miles from its mouth, the Pigeon River descends through deep, narrow gorges by a series of waterfalls and rapids. From South Fowl Lake to Partridge Falls, a distance of 10.6 miles, the gradient of Pigeon River is only 11.3 feet per mile. Along the lower 20 miles the gradient averages 33 feet per mile. The gorge, cascades and falls are conspicuous where the river cuts through the resistant diabase sills and dikes. At High Falls (Fig. 4), the Rove Slate is intruded by a dike, trending N. 50 E., which forms the falls and a ridge on each side of the river. The fall of large masses of diabase from the face, resulting from prominent jointing, produces a vertical wall over which the water plunges a distance of 120 feet. The presence of a second dike, a short distance below High Falls is responsible for another cataract of lesser height. Partridge Falls, 50 feet high, was formed by the intrusion of a diabase dike into the Rove Slate.

On Pigeon River, about one and one-half miles northeast of Partridge Falls, is Split Rock Canyon, a deep narrow gorge cut for the most part in the Rove Slate. The river has cut its channel so rapidly since the recession of the ice-sheet, that little time has elapsed for widening the gorge by weathering and slope wash.

For a distance of about eight miles above Partridge Falls, the Pigeon River flows parallel to the diabase ridges and the escarpment formed by the Keweenawan flows, through a broad open valley on the Rove Slate, with continuous swamps to a point near the outlet of South Fowl Lake and up the Stump River lowland to Stump Lake. There is a great contrast in the course of the Pigeon River, below and above Partridge Falls; the marked difference of a broad, open swampy valley above the steep-sided, narrow gorges with cascades and waterfalls below that point. Apparently the post-glacial Pigeon River has not entrenched its gorge in the old preglacial valley above Partridge Falls.

The unusual course of the Pigeon River is the result of glaciation. As the ice-sheet receded, ponded waters were forced to the south of the ice front which found outlets through the lowest places, including the gaps in and between the diabase ridges where the present cascades and waterfalls are located. It is possible that the glacial waters followed the courses of minor streams which in preglacial time cut across the ridges through gaps or low places.

The preglacial Pigeon River may have drained through one of the broad valleys farther south, perhaps through the swampy lowland now occupied by Stump River and its continuation in a southeasterly direction. Or its route may have been through the old valley above Partridge Falls, following the lowland eastward from the site of Fort Charlotte and along the route through the gaps now followed by the Grand Portage trail which parallels the course of Grand Portage Creek to Lake Superior.

There is evidence to suggest that a preglacial stream existed on the site of the lower Pigeon River. Its mature valley in preglacial time passed through gaps in the diabase ridges similar to those northwest of Grand Portage. The preglacial streams that occupied the present sites of the lower Pigeon River and Grand Portage Creek, flowed through broad valleys where Pigeon Bay and Grand Portage Bay are now located. These rivers, doubtless, emptied into a larger stream which occupied the broad lowland now covered by Lake Superior.

Several factors combine to account for the falls on the north shore tributaries to Lake Superior. The first has to do with the gradual lowering of the lake level since the withdrawal of the ice-sheet from the Lake Superior basin. According to Leverett,[3] the elevations near Grand Marais indicate the highest beaches at 1,206 to 1,275 feet above sea-level or 604 to 623 feet above the present level of Lake Superior. The Algonquin beaches are present at Grand Marais at 1,042 feet above sea-level. Several lower levels are indicated at 785, 760, 725 and 630 feet above sea-level in the same locality.[4] North of Hovland, the upper limit of lake action is about 1,300 feet. At Pigeon River, the upper limit is slightly above that at Hovland and at Mt. McKay at Fort William, Ontario, the highest beach level is 1,350 feet above sea-level or 748 feet above the level of Lake Superior.

According to Leverett[2], the highest beaches at Duluth appear at about 1,135 feet and the lowest at not more than 1,085 feet. The lake levels at Duluth are 60 feet higher than on the south side of the lake, in a distance of 24 miles. It appears that there has been differential uplift of two and one-half feet per mile since the recession of the ice. Leverett points out that the differential uplift of the highest beach, from a point near Schroeder to Poplar River is 33 feet in 13.3 miles or 30 inches to the mile, along the course of the beach. The rate is nearly as great from Lutsen to Grand Marais or to the hill northwest of Hovland where the highest beach is 1,300 feet above sea-level.

The high level of Lake Duluth would bring the water up on the upland to the north. As the level dropped, the gradient to the north shore tributaries was increased. Each successive drop in lake level, produced a sharp rejuvenation at their mouths. Furthermore, the gradual differential uplift and tilting of Lake Superior and its predecessors has produced results favorable to the constant rejuvenation of the streams flowing into Lake Superior from the north. One should not underestimate the importance of the tremendous erosion accomplished by the ice lobe which occupied the Lake Superior lowland and its effect in the steepening of the adjacent slopes. Glacial erosion may have produced hanging valleys along the north shore.

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[3]Idem. 1, p. 59.

[4]Grout, F. F., and Schwartz, G. M. Rove Formation, Minnesota Geological Survey, Bulletin 24, p. 10.

The steep shores of Lake Superior have been attributed to faulting. In the writer's opinion, not enough emphasis has been placed on the effects of glacial erosion in the Lake Superior trough. The lake basin was deepened and its sides eroded, producing on the north side, a steep regular slope which has been modified by the waves and currents since the ice-age.

A feature which can be pointed out here, is that the convex profile of the north shore tributaries to Lake Superior is significant.[4] This is interpreted by the writer as an indication that the erosive power of the streams has not been able to keep pace with the rise of the land.

[4]Idem. 1, Profile of the St. Louis River, Figure 3, p. 9.

REMOVAL OF SODIUM FROM BIOLOGIC MENSTRUUMS BY CALCIUM ZEOLITES

GEORGE B. GORDON, HERBERT A. WEITZNER
AND
ROBERT D. BARNARD[1]

The exchange resin nature of the natural and artificial zeolites has found wide application in industrial water-softening and ammonia removal processes. More recently polysterene resins have been used biologically in the removal of excess hydrogen ion from gastric juice and to inhibit clotting of blood specimens by the removal of calcium ion. In a search for a cheaper material with which to decalcify and recalcify blood plasma reversibly, experiments were undertaken with the commercial zeolite, permutit. During the course of coagulation of citrated blood plasma with calcium zeolite it was observed that a stoichiochemical equivalent of sodium was removed from the plasma and that the zeolite was completely inert insofar as any apparent denaturation effects were concerned. Since the removal of sodium ion may be a desirable end in the treatment of congestive heart disease and thrombophlebetic edema and since this might be accomplished from those menstruums where the presence of calcium zeolites would not be prohibitive (intestinal contents) the feasibility of sodium removal by this means from such menstruums was explored.

Preliminary experiments indicate that the sodium content of neutralized peptic digests can be reduced to traces by one hour's contact with specially prepared calcium permutit. For effective sodium removal within this interval of time, the volume of the permutit must be from one-third to one-half that of the elutate. The administration of permutit in the treatment of congestive heart failure would therefore have to be supplementary to an initially salt-poor diet.

No deleterious effects have so far been observed from the administration of calcium zeolite to human subjects in doses of 10 grams, three times daily.

[1]The experimental work upon which this preliminary report is based was conducted on the Medical and Laboratory Services of the Veterans Administration Hospital, Batavia, N. Y.

LYGAEIDAE COLLECTED IN WESTERN TEXAS, WITH A NEW LYGAEOSPILUS FROM CALIFORNIA

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For a number of years Prof. and Mrs. J. N. Knull, the former Curator of Insects, Department of Zoology and Entomology at The Ohio State University, have collected insects in western Texas and elsewhere in the southwestern states. In this list of Lygaeidae all records are from western Texas with exception of new species of *Lygaeospilus* from southern California.

Subfamily **Lygaeinae**

Oncopeltus fasciatus (Dallas), Gillespie Co., V–6–46; Chisos Mts., VII–9–'36, VII–17–'46; Davis Mts., VIII–22–'36; VIII–2–'37; Brownsville, V–31–'39.
Oncopeltus sexmaculatus Stål, Brownsville, VIII–8–'37.
Lygaeus reclivatus Say, Chisos Mts., VII–17–'46.
" " *enotus* Say, Chisos Mts., VII–17–46.
" *kalmii* Stål, Davis Mts., V–27–'35; Uvalde, V–23–'35.
" *belfragei* Stål, Gillespie Co., VI–14–'34; Davis Mts., VII–2–'40.
" *uhleri* Stål, Davis Mts., VIII–22–'36.
" *lineola* Dallas, Brownsville, V–15–'35, VIII–8–'37.
" *carnosulus* Van Duzee, Brownsville, V–8–'35, VIII–8–'37.
" *nigrinervis* Stål, Val Verde Co., V–13–'46.
" *bicrucis* Say, Chisos Mts., VIII–9–'36; Davis Mts., VI–8–'39; Maud, IV–29–'41.
" *lateralis* Dallas, Davis Mts., V–27–'35, VII–6–'36; Lasca V–30.
Lygaeospilus tripunctatus (Dallas), Gillespie Co., IV–7–'46; Uvalde, V–30–'36.
" *pusio* (Stål), Gillespie Co., V–7–'46.
Lygaeospilus fusconervosus new species.

General color fuscous, with the following parts fusco-rufous: anterior margin, humeral angles and posterior median line of pronotum, corium with costal margins anteriorly, inner claval and commissural margins, a small spot on posterior margin at apex of median (cubitus) vein. Surface between the fuscous veins dull pruinose. Membrane opaque, dull slate gray, outer and basal margins in part narrowly margined with white, veins fuscous.

Vestiture of head, pronotum and corium consists of very fine, short, inclined hairs, those of corium somewhat longer; devoid of the long, soft pile characteristic of the other two species in the genus.

Beneath, with following parts sordid white: bucculae, wide anterior margin of prosternum, posterior margins of pro- and mesopleura, and acetabular caps; orifices black; lateral margins of venter obscurely rufo-fuscous. Femora fuliginous.

Head just over one-fourth wider than long, unicolorous. Ocelli rubinous. Antenna almost half as long as entire body, second segment over twice as long as basal, third segment about one-third longer than basal and nearly one-third shorter than second, terminal a little shorter than second and covered with very fine, short, inclined hairs. Pronotum about one-third wider than long, sparsely, coarsely punctate on depressed surfaces before and behind cicatrices; transverse area bearing cicatrices somewhat elevated, followed by a median, longitudinal carina extending to posterior margin. Scutellum nearly one-third wider than long, deeply depressed at base and posteriorly on either side of middle, appearing as rounded pits, between which is a rounded carina extending to apex. Corium with veins (Cu and R+M) strongly elevated. Membrane scarcely extending beyond apex of abdomen. Length ♂ 4.7 mm.

Type male: Santa Rosa Mts., California, VI–25–'46 in collection of The Ohio State University. Described from a single specimen.

In his revision of the genus *Lygaeus* (Proc. Ent. Soc. Washington, XXIII, 1921) the author briefly described the new subgenus *Lygaeospilus* with *Aphanus tripunctatus* Dallas as type and added *Lygaeus* (*Melanocoryphus*) *pusio* Stål to it. In a more recent study of the genus he has come to the conclusion that this as well as several other subgenera of Stål should be raised to generic rank.

Lygaeospilus is most closely related to the European genus *Lygaeosoma* Spinola. It can be distinguished from that genus by the longer commissure, by the erect or inclined hairs, at least on the corium, as well as by the black orifices.

Nysius californicus alabamensis Baker, Chisos Mts., VII–17–'46; Davis Mts., VI–2–'37.
" *tenellus* Barber, Davis Mts., VI–2–'37.
" *raphanus* Howard, Davis Mts., VIII–2–'37.

Subfamily **Blissinae**

Ischnodemus macer Van Duzee, Davis Mts., VII–2–'40, VII–28–'46; Chisos Mts., VII–17–'46.

Subfamily **Geocorinae**

Geocoris punctipes (Say), Davis Mts., VII–6–'32; Uvalde, VI–30–'36.
" *lividipennis* Stål, Gillespie Co., V–2–'35, VI–14–'34.

Subfamily **Pachygronthinae**

Phlegyas annulicrus Stål, Gillespie Co., V–7–'46.

Subfamily **Rhyparochrominae**

Heraeus plebejus Stål, Brownsville, V–8–'35, V–22–'35.
" *cinnamomeus* new species.

Head, pronotum and scutellum cinnamomeus; corium testaceus, ferrugineusly punctate, tinged with castaneous on apical angle, preceded by an obscure paler, transverse, testaceous area extending to costal margin. Antenna testaceous, apices of basal three and all of terminal segment, brownish. Legs pale yellow testaceous with apices of all femora faintly brown. Membrane tinged with brown, inconspicuous spots at base and apex.

Head shining, narrowly oval, about one-third longer than wide (60x38); preocular very nearly one-fifth longer than posterior part; viewed laterally eye rather large, occupying about half depth of head; vertex very little elevated above dorsal line of eye. Antenna about three times as long as head; second segment about twice as long as basal; third segment a third longer than basal and terminal seomwhat shorter than second. Pronotum less shining, as long as head; anterior lobe much longer and narrower than posterior and very nearly smooth; posterior lobe a little paler, coarsely punctate. Scutellum dull, a little longer than wide, coarsely punctate on depressed base and along sides. Beneath cinnamomeous, pleura darker and duller than abdomen; posterior margin of metapleura and acetabular caps a little paler. Fore femur rather strongly incrassate, with a premedian larger spine, between which, the apex with two rows of spinules. Length 6.5–7 mm.

H. cinnamomeus is very closely related to *H. coquillettei* Barber. In fact this new species was included by me in the series of specimens of that species when the description was drawn up. The cotypes of *coquillettei* from Brownsville, Texas, should be referred to *cinnamomeus*, which is distinguished chiefly by the duller appearance of most parts, relatively larger eyes and more abruptly rounded basal part of head.

Type male: Brownsville, Texas, VI–5–'04 (H. S. Barber collector), and 22 paratypes, males and females, from the same locality in the collection of the United States National Musuem; 7 paratypes, same locality (D. J. and J. N. Knull), collection of The Ohio State University; 5 paratypes, same locality, collection of Texas A. and M. College; 2 paratypes, same locality, author's collection.

Ligyrocoris abdominalis (Guérin), Uvalde, V–30–'36.
" *aurivillianus* (Distant), Brownsville, VI–8–'34.
" *nitidicollis* (Stål), Val Verde Co., VI–28–'40.
" *nitidulus* (Uhler), Davis Mts., VII–22–'36, VIII–22–23–'36, IX–2–'40.

Pachybrachius vincta (Say), Brownsville, V–15–'35.
Paromius longulus (Dallas), Brownsville, V–15–'35; Gillespie Co., VI–23–'40.
Zeridoneus knulli new species.

The following parts somewhat shining black: head, pronotum, scutellum, except at extreme apex, which is testaceous yellow; corium dull black, except for narrow yellow testaceous costal margin. Antenna testaceous, apical part of third and all of fourth segment, fuscous. Legs yellow testaceous; broad middle region of anterior femora and apices of tibiae fuscous. Beneath black.

Very similar to *Z. costalis* (Van Duzee) in general appearance and relative proportion of body parts. Anterior lobe of pronotum is shorter in relation to posterior lobe than in *costalis* and more sparsely and less coarsely punctate; constriction between the two lobes is deeper, as viewed both dorsally and laterally, and spines of the fore femora are arranged differently in *knulli*. The two post median longer spines are set closer together with no intermediate smaller spines, and preapical spines more numerous.

Type male: Gillespie Co., V–7–'46. In collection of The Ohio State University.

Extochiomera albomaculatus (Distant) Biol. Centr. Amer., Rhynch. I, 400, 1893, Plt. XXXV, Fig. 6.

Both Mr. Van Duzee and the author misidentified this species as Guérin's *minima* from Cuba. Recent receipt of a specimen of the true *minima* from that island indicates quite clearly that we were mistaken. It therefore becomes necessary to find another name for this rather common species occurring in Mexico, Central America and southern United States. Although Distant's description of *albomaculatus* is very inadequate, his figure leaves little doubt that his name will have to be adopted. Brownsville, V–8–'35.
Ozophora depicturata Barb., Uvalde Co., V–3–'41.

Science and the Planned State

"Science" is defined as the "organized body of general demonstrable knowledge about the matter of the universe" without regard to its relationship to human welfare. Science becomes technology when these human relationships become its primary concern. The overlapping of science and technology is admitted, but the distinction is held still valid.

The "planned state" is totalitarianism. Under totalitarianism, the work of the scientist becomes mere technology as all research must then necessarily bear an obvious relationship to the needs of mankind. In modern totalitarian governments, it must even bear a supportive relationship to the currently controlling political philosophy.

Mr. Baker's concern is that Soviet science is currently being so highly (and undeservedly) touted. He brings to attention another side of the story:

(1) The absence of a single Soviet contribution from a list of the 27 "most important scientific discoveries made between the two great wars."

(2) The awfully warped attitude of the politically powerful Soviet geneticist, Lysenko.

(3) The production of an "unduly high proportion of bad and suspect science" by Soviet scientists.

He also endeavors to demonstrate that science will deteriorate under any form of planning. There is, he admits, a place for planning and teamwork in science. This place is in the follow-up of a new line of investigation *after* the primary original discovery has been made. "Science can progress rapidly only if scientists are free to expand the bounds of knowledge wherever, at any given moment, they are expansible." The discovery of the vulnerable points *cannot* be planned because there is too great an element of chance involved. Science by nature cannot prosper under totalitarianism because by nature the scientist accepts the authority of no one and needs the liberty to practice this attitude.—*Elton F. Paddock.*

Science and the Planned State, by John R. Baker. 119 pp. New York, The Macmillan Co., 1945. **$1.75.**

HOLOCONOPS IN THE WESTERN LAKE ERIE REGION (DIPTERA: HELEIDAE)[1]

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In his generic synopsis of Heleidae, Johannsen (1943) listed two Nearctic species in the Leptoconops group, which includes Holoconops. Both of these are from the western and southwestern states.

Leptoconops torrens Townsend was described from New Mexico as belonging to the genus Tersesthes. The first specimens were taken at an elevation of 7000 feet while biting horses, particularly around the eyes (Townsend, 1893). Hoffman (1926) reported and described *L. carteri* from the Sacramento Valley in California. There in late spring and early summer the gnats are vigorous biters, attacking exposed skin or crawling under clothing, and often causing severe itching and swelling. They are reported as being so abundant at times that work in the fields is almost unbearable. Freeborn and Zimmerman (1934) described the male of *L. torrens* and presented evidence indicating that *carteri* is a synonym of *torrens*. They incidentally mention specimens from Texas, thereby extending the known range of the species. Johannsen (1943) also mentions the occurrence of *torrens* in Colorado.

Holoconops kerteszi Kieffer was described in 1908 from Egypt. The species was subsequently reported from the mountainous region of Tunis and later from lower altitudes. In his revision of the genus Leptoconops, Carter (1921) added a variety, *americanus*, on the basis of specimens from Utah but freely admitted the absence of good distinguishing characters. Later (1934), Freeborn and Zimmerman studied California specimens which seemed to unite *americanus* with the typical *kerteszi*. In California, the species inhabits a district of wind-swept hills, salt marsh, dune, and beach (Freeborn and Zimmerman, 1934). The specimens first collected in Utah were recorded as "biting devilishly" (Carter, 1921).

On a collecting trip in 1942 along the sandy beach of Lake Erie northwest of Lakeside, Ohio, between East Harbor and West Harbor, the writer's attention was suddenly drawn to a minute punky viciously biting his lower arm. Because of its minute size, the specimen was collected separately in a one-dram vial containing grain alcohol. At the time it was thought to be a specimen of Culicoides. On examination in the laboratory, however, it was found to belong to the Leptoconops group of punkies. The closest described relative was obviously *Holoconops kerteszi*. At first it was thought to be a variant of that species but closer examination revealed differences which seemed too great to be overlooked. It was hoped that additional specimens could be located during widely spaced trips to the area but inasmuch as five years have elapsed without success the specimen is being described as representing a new species.

Holoconops catawbae new species

Female.—Head, thorax, and abdomen nearly uniform reddish brown. Thorax unstriped. Antennae, legs, and lamellae somewhat lighter; legs tending to be lightest in metatarsal area. Frons minutely hairy (430×), with a few larger hairs at the level of the upper margin of the eyes. Eyes reniform, naked. Antennal flagellum (Fig. 2) with 11 joints; terminal joint about 2.5 times longer than wide; basal joint pyriform, all others more or less globular. Terminal antennal segment very slightly longer than three preceding segments. Palps (Fig. 1) probably with four joints but basal joint very indistinct; palps therefore appearing to be three-jointed. Ante-

[1]Contribution from the Franz Theodore Stone Laboratory, Put-in-Bay, Ohio.

penultimate palpal joint small, subspherical; penultimate joint elongate pyriform, with conspicuous sensory pit distinctly distad of middle; terminal joint stalked, clavate. All palpal joints with irregular, transverse rows of setulae (430×). Thorax with scattered hairs about as long as those of antennal flagellum. Scutellum with four distinct bristles. Wings (Fig. 5) whitish, the surface covered with microtrichia (100×); macrotrichia absent. Costa undeveloped except perhaps between apices of R_1 and R_3. Subcostal-radial fusion fairly complete, a longitudinal vein, probably R_1, dividing the area lengthwise. R_5 (designated a longitudinal fold by some authors) distinct to near wing apex. Anterior branch of media present but indistinct, posterior branch absent. Both branches of cubitus visible but evanescent apically. Halteres pale. Metatarsi moderately spiny; other tarsal joints with a few spines. Tarsal claws equal, simple, and without a basal tooth. Fourth tarsal joint on all legs shorter than fifth. Hind tarsus with proportions as follows: 13–10–5–3–4. Abdomen with minute hairs (215×); longer hairs confined to venter and to terminal segments dorsally. Lamellae (Fig. 3) elongate, hairy. Spermathecae (Fig. 4) lemon-shaped, rounded dorsally but showing short stalks ventrally. A small spermatheca-like body visible just posterior to second spermatheca. Wing length, 0.82 mm. Length of lamellae, 0.14 mm. Total length, including lamellae, 1.2 mm. (as measured before specimen was mounted on a slide).

Holotype female, Lakeside, Ohio, July 8, 1942, M. W. Boesel. Preserved in 95 per cent grain alcohol until 1944; then mounted on a glass slide in balsam. Type in author's collection.

KEY TO NEARCTIC SPECIES OF THE LEPTOCONOPS GROUP

1. Antennal flagellum with 13 joints; males.....(2)
1. Antennal flagellum with 11 or 12 joints; females.....(3)
2. Ninth tergite with two short fleshy lobes ventrad of termination, each bearing two long stout bristles; scutetlum with six bristles.....**Leptoconops torrens** ♂
2. Ninth tergite with two long finger-like terminal projections, each with a very short inconspicuous bristle near its middle; scutellum with four bristles.....**Holoconops kerteszi** ♂
3. Antennal flagellum with 12 joints; scutellum with six bristles; abdomen brown, distinctly paler than thorax; total length 2.2 mm.; wing length 1.1 mm.....**Leptoconops torrens** ♀
3. Antennal flagellum with 11 joints; scutellum with four bristles.....(4)
4. Penultimate palpal joint with pore near middle; ultimate palpal joint slightly swollen distally; antepenultimate palpal joint elongate, cylindrical, hardly or little wider than succeeding joint; head and thorax black, abdomen dark brown; legs dark brown; veins R_5 and M_{1+2} convergent apically; total length 1.5–2.1 mm.; wing length 1.1–1.3 mm. **Holoconops kerteszi** ♀
4. Penultimate palpal joint with pore distinctly distad of middle; ultimate palpal joint stalked, apical two-thirds definitely broadened; antepenultimate palpal joint subspherical, distinctly broader than base of succeeding joint; entire body uncoilorous reddish brown; legs light brown; veins R_5 and M_{1+2} subparallel or slightly divergent apically; total length 1.2 mm.; wing length 0.82 mm.....**Holoconops catawbae** ♀

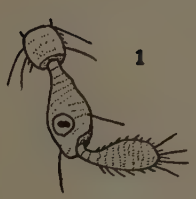
DISCUSSION

At first it was considered probable that the specimen collected in Ohio had been carried into the region from the western or southwestern states. There are familiar accounts of small insects being carried great distances in the air. Specifically, Freeborn and Zimmerman (1934) speak of 'black alkali' locations in California which act as foci from which these "black gnats" are blown by winds over large areas. It is interesting but perhaps not too significant to note that a southwest wind with a velocity of 36 miles per hour was recorded for Cleveland

EXPLANATION OF PLATE

FIGS. 1–5. Details of *Holoconops catawbae* n. sp., female.

Fig. 1. Palp. Fig. 2. Antenna. Fig. 3. Lamella, lateral view. Fig. 4. Spermathecae, lateral view. Fig. 5. Wing.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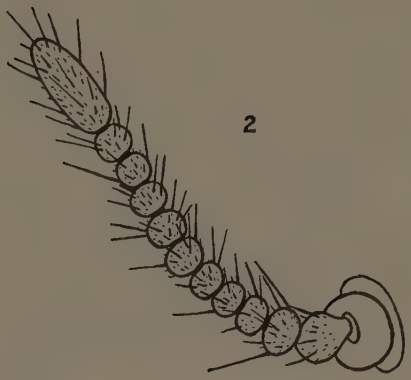
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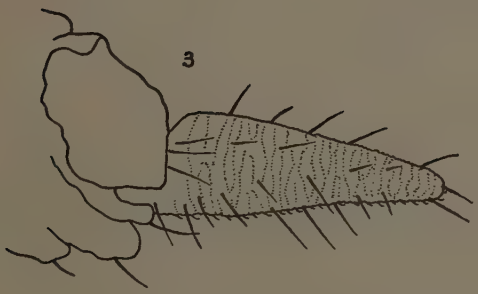
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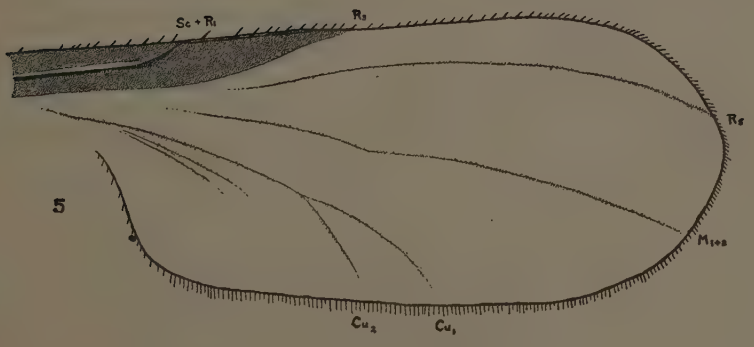
Sc + R1
Rs
Rs
M1+2
Cu2
Cu1
5

on June 30, and a south wind of 40 miles per hour was recorded for the same city on July 3, 1942. In order to have been transported from the nearest recorded locality (Utah) to western Lake Erie, the punky would have had to travel nearly 2000 miles. When the individual was carefully studied and found to differ from *H. kerteszi* in a number of respects, the theory of transmission by air currents or other means seemed much less attractive.

An argument in favor of the conclusion that *Holoconops catawbae* is perhaps breeding sparingly along the shore of Lake Erie is the apparent suitability of the environment for its development. We have little information on the life history of Holoconops but Painter (1926) briefly describes larvae of *H. bequaerti* Kieffer which in Honduras are said to be found nearly always burrowing in wet sand mixed with a little humus along the edges of sea or brackish water; the larvae are recorded as often occurring in beach depressions which are wet but not disturbed by waves. The microscopic nature and burrowing habits of the larvae makes their detection most difficult but it is conceivable that they occur on sandy Lake Erie beaches. It should be emphasized, however, that such beaches are comparatively rare in the region in general. Predominantly there are limestone cliffs, shelves, and pebble beaches.

SUMMARY

1. A single female of *Holoconops catawbae* n. sp. was collected on a sandy Lake Erie beach in the act of biting viciously.

2. *H. catawbae* differs from its closest known relative, *H. kerteszi*, in the following respects: the last palpal joint is stalked and distinctly clavate, the penultimate joint has the pore distinctly distad of the middle, and the antepenultimate joint is subspherical; the body is reddish brown, the legs light brown; veins R_5 and M_{1+2} are subparallel or slightly divergent apically; total length 1.2 mm.; wing length 0.82 mm.

3. Suitability of the environment makes it seem possible that *H. catawbae* is breeding to some extent in the Lake Erie region.

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THE INSTARS OF PHYMATA AND SINEA (PHYMATIDAE, REDUVIIDAE: HEMIPTERA)[1]

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INTRODUCTION

The data on instars presented below were secured as by-products of my study of the weight patterns of *Phymata pennsylvanica americana* Melin and *Sinea diadema* Fabr. in relation to differences in the amounts and kinds of food administered. These studies extended over the years 1942 to 1945. The bugs were caged and fed individually, and kept at 80° Fahrenheit and approximately 80 per cent relative humidity. In this manner, I reared 14 series of *Phymata*, which yielded 176 adults—100 males and 76 females; and 19 series of *Sinea*, from which 127 males and 90 females were secured. Many other individuals failed to become adults, due to insufficient food and to accidents in molting or handling.

The tabulated data, given below, concern the duration of (a) the five instars that usually compose the nymphal stage of these predatory bugs, and (b) the nymphal stage as a whole. Duration in each species is stated in two forms, first (Tables I and II) in terms of days, both the average and the extreme numbers being given, and second (Tables III and IV) in terms of per cents that express the relative value of each instar in the total nymphal period. The durational records for the individual bugs on which these averages, extremes and per cents are based were taken daily, not hourly, as should perhaps have been done. As a result, the records contain errors varying from one to 24 hours. However, some records were quite precise because they chanced to be taken when the bugs were exuviating.

The series of *Phymata* and *Sinea* are arranged in the tables on the basis of the over-all duration of the nymphal life, the shortest being placed first, followed by the successively longer series. This gradation is correlated, in a cause-effect relation, with the amount of *Drosophila melanogaster* L. and *Musca domestica* L. permitted in the plans of the feeding experiments previously reported in other articles. That is, the more adequate the diet, the more rapid or the shorter the nymphal development. In the case of *Phymata* series number 7 (Table I) miscellaneous insects swept from vegetation in the field were substituted for *Drosophila* and *Musca*.

DISCUSSION

The tabulated data afford a basis for consideration of four aspects of instars. First to be treated is the variability in duration of (a) any one instar and (b) the entire nymphal stage under differing amounts of diet but somewhat uniform temperature and humidity. Reference to Table I will show that the total nymphal life of *Phymata* varied from 34 to 185 days, while the five instars exhibited spreads of 6 to 25, 5 to 34, 5 to 58, 6 to 39, and 8 to 34 days, respectively. The total nymphal life of *Sinea* (Table II) varied in length from 28 to 108 days, while the five instars ranged from 5 to 18, 4 to 13, 4 to 21, 5 to 33, and 7 to 48 days, respectively. It will be noted that the spreads given for *Phymata* are decidedly more extreme than those for *Sinea*. However, these figures are not to be accepted as signifying the full potential innate capacities for variation in the two species. They only reflect the ranges obtained incidental to my experiments under unequal

[1]Contribution No. 279 from the Entomological Laboratories of the University of Illinois. Supporting funds were appropriated by the Research Board of the Graduate School.

dietaries. It may be stated with certainty that *Sinea* could be made to vary much more extensively than the above numbers indicate, if determination of its ability to vary were made the prime object of future experiments. Moreover, it is probable that *Phymata* could effect a greater range in time of development if tested further, particularly under a variety of temperatures.

TABLE I

THE INSTARS OF *Phymata*. DURATION IN DAYS

	ADULTS REARED		AVERAGE AND EXTREME DURATION IN DAYS							
SERIES	Males	Females	First Instar	Second Instar	Third Instar	Fourth Instar	Fifth Instar	Nymphal Stage	Nymphal Males	Nymphal Females
1	7	3	7.40 6–8	5.50 5–6	5.60 5–7	7.00 6–8	10.90 10–12	36.40 34–41	35.86 34–38	37.66 34–41
2	11	7	10.28 8–16	6.55 5–10	6.50 5–8	7.00 6–8	10.55 10–12	40.88 36–48	40.45 36–42	41.57 38–43
3	4	3	7.43 7–9	5.71 5–7	6.43 5–8	7.43 7–8	14.86 13–16	41.86 37–44	41.25 37–44	42.66 41–44
4	8	5	10.15 7–14	6.38 4–8	6.15 5–7	7.31 6–8	12.92 11–14	42.91 35–48	42.50 35–48	43.60 43–48
5	15	3	10.61 7–15	7.11 5–10	6.28 5–8	7.33 6–11	10.61 9–13	41.94 36–48	42.00 36–48	41.67 41–43
6	15	5	9.70 8–14	8.20 5–11	5.70 5–6	7.25 6–9	12.00 10–14	42.85 39–47	41.87 39–45	45.40 44–47
7	7	9	10.50 6–16	7.00 5–11	6.88 5–9	8.56 7–17	11.44 8–14	44.38 38–56	44.29 41–48	44.66 38–56
8	6	6	12.08 9–14	7.50 5–10	7.66 6–10	8.50 7–10	13.00 11–16	48.74 43–56	48.00 43–56	49.17 45–52
9	8	7	11.21 9–13	7.73 7–9	7.60 6–10	9.47 8–11	13.80 10–17	49.81 46–56	48.50 46–52	51.43 47–56
10	5	7	14.75 11–19	8.91 7–11	9.08 8–11	9.50 8–12	15.33 14–16	57.57 53–67	56.60 55–58	58.28 53–67
11	6	7	15.16 9–24	10.23 6–14	13.07 9–11	11.62 10–13	11.77 16–23	61.85 58–78	66.33 58–78	67.14 62–77
12	5	5	16.20 12–20	15.40 10–22	14.70 12–16	18.60 14–22	23.30 18–28	88.20 79–103	85.40 79–92	91.00 85–103
13	3	8	20.27 13–25	23.20 12–37	27.82 20–40	26.36 16–42	40.54 32–63	138.19 114–176	133.67 121–152	139.88 117–176
14	0	1	20.00	34.00	58.00	39.00	34.00	185.00	.....	185.00

The second aspect concerns the differences in duration of growth between the two sexes of the species. With several exceptions in the case of *Sinea*, the reared series of the two bugs indicate that the females required a significantly greater number of days for their total nymphal growth, and therefore also for the several component instars, than the males (Tables I and II). This intersexual difference in time required to attain adulthood appears to be hereditary and

TABLE II

THE INSTARS OF *Sinea*. DURATION IN DAYS

Series	Adults Reared		Average and Extreme Duration, in Days							
	Males	Females	First Instar	Second Instar	Third Instar	Fourth Instar	Fifth Instar	Nymphal Stage	Nymphal Males	Nymphal Females
1	8	3	7.18 5–9	4.36 4–5	4.36 4–5	5.73 5–68	8.36 8–9	30.00 28–33	30.1 28–31	29.7 29–30
2	4	5	8.10 7–9	4.44 4–5	4.77 4–7	5.77 5–9	9.33 9–11	32.41 30–41	31.00 30–34	33.60 30–41
3	6	3	8.66 6–12	4.77 4–6	5.00 4–6	6.11 5–10	9.11 8–11	33.65 29–41	35.00 29–41	31.00 29–32
4	8	7	7.53 6–9	5.40 4–8	4.93 4–6	6.27 5–12	9.60 7–18	33.73 28–51	31.13 28–36	36.71 34–51
5	7	8	7.53 6–9	5.73 4–7	5.40 4–8	6.86 5–15	9.80 8–13	35.32 30–51	35.14 30–48	35.50 30–51
6	4	4	6.87 6–9	6.00 5–7	5.75 4–8	6.87 6–10	10.25 8–21	35.74 30–51	36.25 30–51	35.25 33–37
7	10	4	8.00 6–12	5.36 4–8	5.21 4–6	6.64 5–12	11.21 9–25	36.42 29–58	36.7 29–58	35.75 33–39
8	8	6	8.50 6–15	5.50 5–8	5.36 4–7	6.64 5–11	12.86 8–31	38.86 30–64	40.50 30–64	36.66 31.46
9	7	2	7.22 6–9	6.11 4–8	6.22 4–8	8.44 6–14	13.33 8–25	41.32 30–58	43.86 35–58	41.50 30–53
10	10	4	10.43 8–17	7.79 6–9	5.86 5–7	9.21 6–15	12.50 8–19	45.79 37–60	47.30 39–60	42.00 37.46
11	7	7	9.43 5–13	7.50 5–10	6.14 5–8	8.64 5–16	14.71 9–26	46.42 30–63	41.86 30–51	51.00 39.63
12	13	6	10.53 7–15	7.15 4–9	6.26 4–10	8.79 5–13	13.89 8–31	46.62 32–69	43.92 32–55	52.50 46–69
13	8	8	10.10 7–12	7.25 6–8	6.25 5–8	10.00 5–16	14.12 9–22	47.72 35–60	46.25 35–60	49.25 44–58
14	9	9	11.55 9–18	7.61 5–9	6.17 5–7	9.94 7–12	16.67 11–24	51.94 46–58	50.67 46–58	53.20 48–55
15	2	2	6.00 5–7	8.00 7–9	10.00 8–12	14.00 11–21	18.25 13–24	56.25 49–72	50.00 49–51	62.5 53–72
16	1	0	11.00	8.00	14.00	7.00	22.00	62.00	62.00	00.00
17	10	1	10.18 8–12	9.09 7–12	10.82 9–14	15.36 10–22	25.36 15–40	70.81 52–95	70.60 52.95	63.00 .....
18	2	4	11.00 9–14	8.40 5–11	13.00 7–18	16.80 11–22	21.00 19–23	70.20 55–82	55.00 55–55	80.30 79–82
19	3	7	12.10 10–16	10.30 8–13	12.40 5–21	19.80 10–33	27.00 19–48	81.60 50–108	80.33 64–89	82.14 59–108

associated with the normal difference in bodily bulk, the females of both species being the larger. The data for *Phymata pennsylvanica* are to be taken as the more nearly correct, for the reason that the performance of this species is more

TABLE III

Phymata. Duration of Instars, in Per Cents

Series	What Per Cent Each Instar Contributes to the Duration of the Entire Nymphal Life				
	First	Second	Third	Fourth	Fifth
1	20.35	15.11	15.38	19.23	29.95
2	25.14	16.02	15.90	17.12	25.80
3	17.75	13.64	15.36	17.75	35.49
4	23.65	14.87	14.33	17.03	30.11
5	25.27	16.95	14.91	17.48	25.30
6	22.63	19.14	13.30	16.92	28.00
7	23.62	15.77	15.50	19.29	25.78
8	24.78	15.38	15.72	17.44	26.67
9	22.51	15.52	15.26	19.01	27.71
10	25.62	15.48	15.77	16.50	26.63
11	24.51	16.54	21.46	18.72	19.30
12	18.37	17.46	16.66	21.09	26.42
13	14.67	16.79	20.13	19.08	29.34
14	10.81	18.38	31.35	21.08	18.38

TABLE IV

Sinea. Duration of Instars, in Per Cents

Series	What Per Cent Each Instar Contributes to the Duration of the Entire Nymphal Life				
	First	Second	Third	Fourth	Fifth
1	23.93	14.53	14.53	19.10	27.87
2	24.99	13.70	14.71	17.80	28.79
3	25.73	14.17	14.86	18.16	27.07
4	22.32	16.01	14.61	18.59	28.46
5	21.32	16.22	15.29	19.42	27.75
6	19.22	16.79	16.09	19.22	28.68
7	21.97	14.72	14.31	18.23	30.78
8	21.82	14.15	13.79	17.09	33.09
9	17.47	14.78	15.05	20.42	32.26
10	22.78	17.01	12.79	20.12	27.30
11	20.31	16.16	13.23	18.61	31.69
12	22.59	15.34	13.42	18.86	29.79
13	21.16	15.19	13.10	20.95	29.59
14	22.24	14.65	11.89	19.14	32.09
15	10.66	14.22	17.78	24.89	32.44
16	17.74	12.90	22.58	11.29	35.48
17	14.38	12.84	15.28	21.69	35.81
18	15.67	11.91	18.52	23.93	29.91
19	14.83	12.62	15.20	24.26	33.09

nearly normal in captivity than that of *Sinea*, *Phymata* being decidedly more efficient in capturing both the small *Drosophila* and the larger *Musca*, and therefore comes closer to realizing its inherent potentialities for growth.

The third topic suggested by the tabulated data concerns the question whether the instars of these insects possess what may be described as an ideal durational pattern, and, if so, what are its characteristics? by "ideal durational pattern" I mean (a) the most rapid development on the one hand, and (b) the most prolonged development of which the species is capable under a given set of environmental and hereditary conditions. Such a pattern implies that not any one or two, but *all* the instars of the nymphal life are completed in (a) the least amount of time or (b) the maximum amount of time possible for the species. It represents, on the one hand, the irreducible minimum, and, on the other, the inextensible maximum time period in which the species can complete its growth from the event of hatching to transformation to the adult form. The value of the pattern is not fixed, set or absolute, for it changes with alteration of the environment, particularly food, temperature and relative humidity, and the peculiar combination of hereditary traits possessed by the individuals subjected to experimentation.

What actual values enter concretely into the composition of these ideal patterns of instars in the cases of *Phymata* and *Sinea?* Too few data are at hand to permit further consideration of the maximum pattern, which is secured by use of the most attenuated diet and the most adverse temperatures and humidities the species can tolerate and still grow to adulthood. However, the data provided in the most adequately nourished series of *Phymata* (Ser. 1, Table III) affords some idea of the features that possibly characterize the ideal minimum developmental pattern of this species. Expressed in terms of per cents and round numbers, this pattern is 20, 15, 15, 20, and 30 for the five instars, respectively. Here the first and fourth instars are of equal duration, as are also the second and the third, while the fifth is equal to the second and the third combined, and one-half longer than either the first or fourth.

It will be observed from series 1 to 6, Table IV, that the minimum pattern for *Sinea* conforms in some respects to that of *Phymata* just described, but differs from it in others. While the second and third are approximately equal and also the shortest of the five instars, and the fifth required about as much time as the second and third combined, the fifth is relatively shorter than either the first or the fourth. Are these differences between the minimum patterns of the two species inherent and characteristic, or are they results of unequal dietaries? I am inclined to the latter view for the following reasons.

First, the proportionately greater duration of the first instar of *Sinea* may arise from a degree of ineptitude in capturing *Drosophila* and also may be due to a supply of nutrient known to be carried over into the nymph from the egg, and which effects a delay in growth and thus a prolongation of the instar. On the other hand, the relatively greater length of the fifth instar is probably the result of (a) the inability of the nymphs in that stadium to secure enough *Drosophila* and (b) their disposition to avoid the boisterous *Musca*, with the consequence that *Sinea* fails to ingest sufficient food to meet its needs for maximum growth and to realize its ideal time pattern under the captive conditions imposed.

The fourth feature of instars indicated by the tabulated data relates to the number of instars that composes the total nymphal stage. In the course of rearing 393 adult bugs individually, I had an opportunity to determine the number of growth periods with considerable precision. Despite the extreme variation secured in length of nymphal stages due to the great range of dietary imposed on the several series of *Phymata* and *Sinea*, only one individual positively departed from the usual number of five instars by adding a sixth. The exception was a male *Sinea* that was provided a maximum number of *Drosophila* each day throughout his nymphal life. The duration of the total nymphal period was not significantly increased by the added instar, it being 49 days. Seven other males, of the same series and dietary, completed their five instars in an average of 44 days, with

extremes of 35 and 58. That is, the addition of an instar had the effect of abbreviating the inter-molt periods rather than increasing the length of the over-all nymphal stage.

In conclusion, I should like to suggest further studies on the question of insectan instars. Does the pattern generally follow a common design, in which the first and last instars are longer than the intermediate ones? What underlying structures or processes, possibly such as cuticular characters, glandular functions, cell division and rate of ingestion, determine the relative per cent of time each instar consumes in the course of nymphal growth?

HONORING PROFESSOR WILLIAM A STARIN

Doctor William A Starin of the Ohio State University, Department of Bacteriology, will retire from active service at the end of this academic year after 38 years of teaching in the Department. Plans are being made by friends and former students to honor him on this occasion, and a sincere effort is being made to reach all who might wish to have a part in these plans. Letters are being sent to those for whom addresses are known, and it is hoped that those who do not receive letters will take this notice as a personal invitation to participate in the program so far as is possible. There are two important parts of the program to be noted:

First: The William A. Starin Lectureship has been established through the Ohio State University Development Fund and will be administered by the Department of Bacteriology in consultation with the Dean of the Graduate School. All of Doctor Starin's friends and former students who can be contacted are being asked to send such contributions as they desire for this fund. The money will become part of the University's permanent endowment and will, it is hoped, yield an income sufficient to provide an annual speaker. Checks should be made payable to the Ohio State University Development Fund.

Second: A dinner in Doctor Starin's honor is being arranged for Saturday, May 8, at the Neil House in Columbus, and all friends and former students who can do so are invited to attend. It is important that tentative reservations be made immediately. Definite reservations must be made by May 1.

Checks for the Lectureship, and reservations for the dinner should be sent to Dr. Margaret D. Heise, Department of Bacteriology, Pharmacy and Bacteriology Bldg., Ohio State University. For further information, please call or write Dr. Heise, or Marian Estep, Department of Physiology, Hamilton Hall, Ohio State University.

WIND DIRECTIONS

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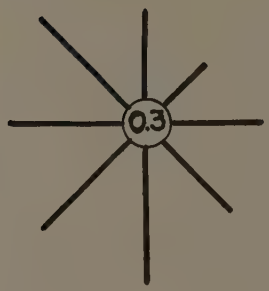
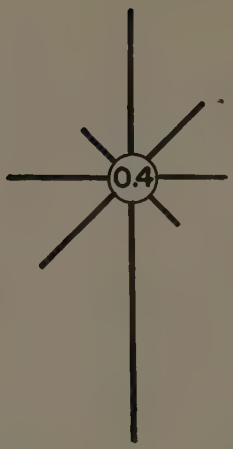
In the middle latitudes of the northern hemisphere, extending approximately from 40° north latitude to the subpolar lows in the vicinity of the Arctic Circle are the so-called Prevailing Westerlies or Southwest winds. The air moves out of the poleward areas of the subtropical regions of high pressure toward the subpolar lows and due to the earth's rotation the winds are deflected as they move into the higher latitudes, becoming southwest winds in the northern hemisphere and northwest winds in the southern latitudes. The Westerlies are a part of the well-known and often misapplied Planetary Wind system, or general air curculation of the earth. This general circulation system must be considered only as a background upon which more varied patterns of air movements take place. The practice on the part of some earth scientists to refer to the General Circulation as primary and all other air movements such as air masses, monsoons, local winds and the like as secondary is hardly in accordance with their relative significance, particularly, when reference is made to surface winds. The diversification and complexity of the factors affecting air movement are so great that any generalization has comparatively little importance.

The accompanying graphic representations of wind directions, the Wind Roses (Figs. 1–2), do reflect the principles of the Earth's general circulation; however, the fact that there are other influences, or disturbances, is equally in evidence. Local conditions, the degree of exposure and elevation of recording instruments are clearly represented in the Columbus Wind Roses (Fig. 1). When the Weather Station was located on Broad Street, the records of wind direction for the period 1918–1930, show a high prevalency of westerly winds. Later, when the station was moved to Marconi Street, the records for the years 1935–45 disclose that the predominant wind direction is south. The difference is undoubtedly due, primarily, to local circumstances. The recording instruments at the Broad Street location were 239 feet above ground (surface elevation 760 feet above sea-level) whereas the present Marconi Station wind meters are 110 feet above the street level (surface elevation 724 feet above sea-level). Furthermore, the Marconi Street Station has less free exposure than the former Broad Station. It may also be added that the wind velocity average is less at the lower elevation, namely, the Marconi Street position, than at the former Broad Street Station. In all probability, the difference in the records of the two Cleveland Stations (Fig. 1) likewise are indicative of difference in local conditions.

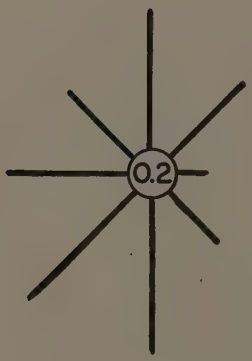
These preliminary notes, concerning wind directions in Ohio, have been made in full recognition of the Significance of the Earth's general air circulation as well as to emphasize the equally important but often misplaced and misnamed secondary air movements.



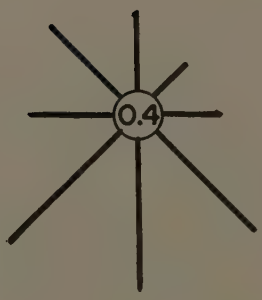
COLUMBUS, OHIO
BROAD STREET
1918 - 1930



COLUMBUS, OHIO
MARCONI STREET
1935 – 1945



CLEVELAND, OHIO
DOWNTOWN
1890 - 1930



CLEVELAND MUNICIPAL
AIRPORT
1942 - 1945

FIG. 1. Wind Roses.

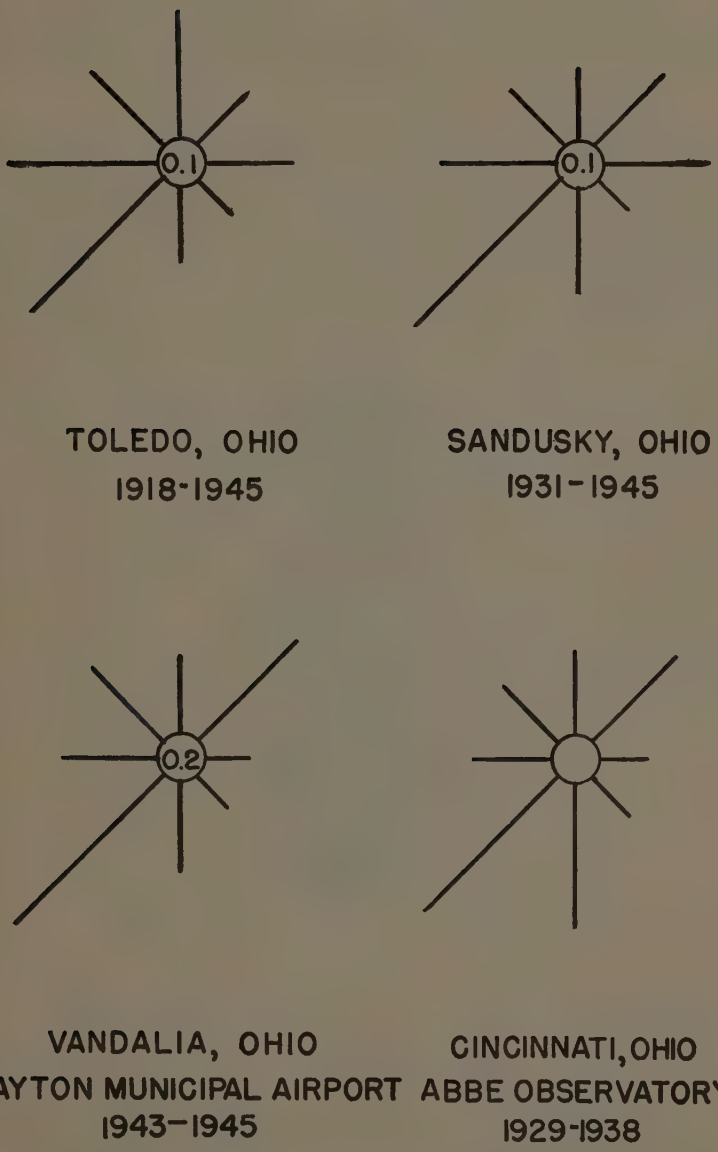


Fig. 2. Wind Roses.

NEW GENUS AND SPECIES OF CERAMBYCIDAE WITH NOTES (COLEOPTERA)

J. N. KNULL,
Department of Zoology and Entomology,
The Ohio State University

Romulus n. g.

Head convex, concave in front; base of antenna partly enveloped by coarsely granulate eye, segments three to eleven inclusive somewhat flattened, sensory areas forming carinae on outside of last six segments, apices of segments three to six inclusive angulate on inside giving faint indication of spines.

Fig. 1. *Romulus globosus* n. sp. Line equals 5 mm.

Prothorax globose; disk of pronotum convex with median depression at base and two slight elongate, pubescent depressions each side at about middle.

Elytra at base wider than widest part of pronotum; apices emarginate, forming angle on each side of emargination.

Anterior coxal cavities open behind, middle coxal cavities closed behind. Metathoracic episterna narrowed posteriorly. Legs stout.

Genotype: *Romulus globosus* n. sp.

This genus should be placed in Phoracanthini next to *Romaleum*. In male it differs from this genus by globose, smooth pronotum, lack of definite spines on antennae or elytral apices.

Romulus globosus n. sp.

Male: Robust; color dark reddish brown, head and prothorax darker; pubescence short, inconspicuous.

Head finely, densely punctured; antennae extending over two segments beyond apices of elytra, scape stout, second segment as long as wide, third longer than scape, fourth shorter than third, fifth to ninth inclusive about equal to third, tenth shorter than ninth, eleventh equal to third.

Pronotum globose, widest in middle, sides broadly rounded from base to apex, disk convex; surface more finely and densely punctate than head. Scutellum obtusely angled in rear.

Elytra at base wider than widest part of pronotum; sides subparallel in front, broadly rounded to apices from about middle.

Abdomen beneath more densely pubescent, finely densely punctate; last visible ventral segment broadly rounded.

Length 29 mm.; width 9.5 mm.

Holotype male labeled Coral Gables, Fla., May 20, 1943, H. Conger collector. Paratypes, same locality, May 10, 1929; Ocala National Forest, Fla., July 27, 1938, Hubbell and Friauf, all in collection of author. Paratype from Crescent City, Fla., Hubbard and Schwarz, in U. S. National Museum.

The author is indebted to Dr. H. F. Strohecker for material and to Mr. W. S. Fisher for loan of material and comparison with West Indian species.

Elytroleptus ignitus Lec.

Adults were taken from foliage of large oak tree on July 16, 1937, in Huachuca Mountains, Ariz., where they were associated with *Lycostomus femoratus* Schffr., which they closely resemble. It was extremely difficult to pick active cerambycids from the large number of lycids which fell into umbrella at same time. Other trees in immediate vicinity did not yield material.

Neoptychodes trilineatus var. **insularis** (Fairm.)

Breeds in bases of living willow (*Salix* sp.) in Chiricahua Mountains, Ariz.

Tetraopes discoideus Lec.

Taken on low milkweed, May 25–31, 1939, at Brownsville, Tex.

SOME ALGAE FROM THE BLACK HILLS OF SOUTH DAKOTA AND THE TURTLE MOUNTAIN REGION OF NORTH DAKOTA[1]

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During June, 1939, the writer came into possession of a series of algal samples collected by Dr. R. T. Wareham, of the Botany Department, The Ohio State University. The first eight in the series were from the vicinity of Spearfish in the Black Hills of South Dakota. Representative of stream habitats, these were the least interesting of the series, both in number and variety of species. The remaining twenty collections were from the Turtle Mts. of North Dakota in the vicinity of Bottineau, Lake Metigoshe, Dunseith, and Boundry Butte. These were of decided interest and were characteristic of the northern bog-lake areas in which desmids predominate.

The most comprehensive account of the algae of North Dakota is found in two papers, one by Moore (1917) and the other by Moore and Carter (1923). The first was a study of the algae in Devil's Lake, while the second dealt with the algae in numerous lakes of northeastern North Dakota, including some of the area concerned in the present report. The main objective, as summarized in the second paper, was to contrast the algal flora of the "freshwater" and "alkaline" lakes. This paper listed a total of 148 named species and varieties with their distribution in the two types of lakes. Nine additional species and varieties recorded only from Devil's Lake (1917) increased the records to 157 for the region.

Of the 73 forms in the present report, 12 have been previously listed, and are designated by an asterisk. The list, though not extensive, indicates that a study of the algal flora of the Turtle Mts. would be well worth the effort involved.

The writer wishes to thank Dr. Wareham for the time and effort expended in securing the collections.

Species List

Black Hills, South Dakota

Nostoc verrucosum Vauch.
Protococcus viridis Ag.
Ulothrix tenerrima Kütz.
Ulothrix zonata (Weber & Mohr) Kütz.
Cladophora glomerata (L.) Kütz.
Vaucheria borealis Hirn.
Closterium leibleinii Kütz.

Turtle Mountains, North Dakota

Cyanophyta
**Chroococcus turgidus* (Kütz.) Näg.
**Chroococcus limneticus* Lemm.
**Microcystis incerta* Lemm.
Aphanocapsa elachista var. *conferta* W. & W.
Aphanothece stagnina (Sprengel) A. Br.
**Merismopedia tennuissima* Lemm.
Nostoc commune Vauch.
Chrysophyta
Dinobryon sertularia Ehr.
Ophiocytium arbusculum (A. Br.) Raben.
Tribonema utriculosum (Kütz.) Hazen

[1]Paper from the Department of Botany, The Ohio State University, No. 493.

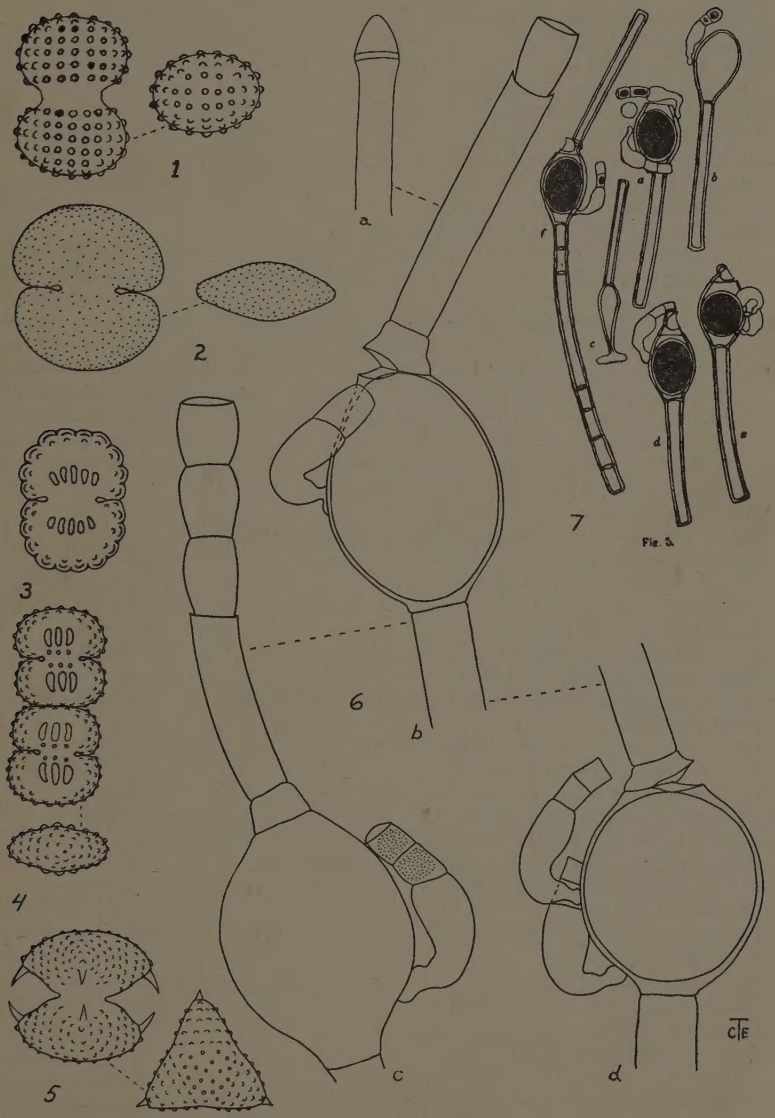

FIG. 1. *Cosmarium isthmium* West *forma*. FIG. 2. *Cosmarium lundellii* var. *corruptum* (Turner) W. & W. FIG. 3. *Cosmarium saxicolum* Kaiser. FIG. 4. *Cosmarium vogesiacum* Lemaire *forma*. FIG. 5. *Staurastrum dakotii* sp. nov. FIG. 6a-d. *Oedogonium hoersholmiense* Hallas. A, apical cell; b, c, d, fruiting filaments with androsporangia and dwarf males. FIG. 7. *Oedogonium hoersholmiense* Hallas. From the original figures by Hallas.

Chlorophyta

**Pandorina morum* (Müll.) Bory

**Eudorina elegans* Ehr.

Gloeocystis ampla Kütz.

Asterococcus limneticus G. M. Smith

**Cylindrocapsa geminella* Wolle

Stigeoclonium subsecundum Hazen

Microthamnium kuetzingianum Näg.

Microthamnium strictissimum Raben.

**Rhizoclonium hieroglyphicum* (Ag.) Kütz.

Oedogonium hoersholmiense Hallas. Figs. 6a-d, 7.

Veg. cell 8–16 x 68–160μ; oogon. 42–48 x 60–72μ; oosp. 39–45 x 42–46 (–58)μ; androsp. 13–19 x 16–21μ; dwarf male stipe 11–14 x 29–32μ; antheridium 9–11 x 9–16μ.

Lake Metigoshe, N. Dakota.

Oed. hoersholmiense appears to be a rarity. Tiffany (1930) lists its distribution as Denmark, where it was first described by Hallas (1905). Later (1937) Tiffany listed it as an extra-linital species in his work on the North American Oedogoniaceae. The North Dakota material has been assigned to this species with some trepidation although it agrees remarkably well with the figures published by Hallas. The dimensions, especially the breadth of the oogonia and oospores, are greater, but it is the writer's opinion that these are nearer the upper extremes for the species and therefore should be included in the description.

**Pediastrum boryanum* (Turp.) Menegh.

Pediastrum araneosum var. *rugulosum* (G. S. West) G. M. Smith

**Ankistrodesmus falcatus* (Corda) Ralfs

Tetraedron minimum (A. Br.) Hansg.

Scenedesmus armatus (Chod.) G. M. Smith

Scenedesmus arcuatus Lemm.

Scenedesmus acutiformis Schröder

**Scenedesmus obliquus* (Turp.) Kütz.

**Scenedesmus quadricauda* var. *quadrispina* (Chod.) G. M. Smith

Vaucheria hamata (Vauch.) D. C.

Spirogyra condensata (Vauch.) Kütz.

Spirogyra hassallii (Jenner) Petit

Cylindrocystis brebissonii var. *minor* W. & W.

Netrium digitus (Ehr.) Itzg. & Roth

Netrium digitus var. *naegelii* (Bréb.) Krieger

Pleurotaenium ehrenbergii var. *crenulatum* (Ehr.) Krieger

Closterium acerosum (Schrank) Ehr.

Closterium kutzingii Bréb.

Closterium moniliferum Näg.

Closterium parvulum Näg.

Euastrum abruptum Nordst.

Euastrum binale var. *hians* W. West.

Cosmarium amoenum Ralfs

Cosmarium angulosum Bréb.

Cosmarium connatum Bréb.

Cosmarium impressulum var. *suborthogona* (W. & W.) Taft

Cosmarium isthmium West forma? Fig. 1.

L. 40μ, w. 29μ, isth. 14μ.

Somewhat more compressed in vertical view but in agreement with the material figured by Wailes (1931) from British Columbia.

Cosmarium lundellii var. *corruptum* (Turn.) W. & W. Fig. 2.

L. 41–43μ, w. 44–45μ, isth. 13–14μ.

The dimensions of this material are somewhat less than those by Turner (1892) and decidedly less than those by West & West (1905). If this variety as proposed by the Wests, is a complex of three of Turner's species and varieties, then a great variation in size may be expected. Listed here as var. *corruptum*, the material resembles *Cos. corruptum* Turner more than *Cos. subcirculare* var. *rugosum* Turner or *Cos. rotundatum* which the Wests maintain are parts of the complex.

Cosmarium obtusatum Schmidle
Cosmarium ochthodes Nordst.
Cosmarium punctulatum Bréb.
Cosmarium pyramidatum Bréb.
Cosmarium quadratum Ralfs
Cosmarium rectangulare var. *hexagonum* (Elfv.) W. & W.
Cosmarium saxicolum Kaiser. Fig. 3.

L. 30μ, w. 24μ, isth. 11μ.

The North Dakota material agrees very closely with Gronblad's figures (1932). The cells have less ornimentation and are smaller than those figured by Krieger (1938).

Cosmarium sexangulare Lund
Cosmarium speciosum Lund
Cosmarium subarctoum (Lager.) Racib.
Cosmarium subcucumis Schmidle
Cosmarium vexatum West
Cosmarium vogesiacum Lemaire forma? Fig. 4.

L. 24–26μ, w. 22–24μ, isth. 8–9μ.

This form differs from the species in having 3 parallel protuberances on the central face of each semicell. The dimensions are almost exactly those of the species as well as of var. *alpinum* (Schmidle) Laporte. (Laporte, 1931).

Staurastrum dakotii Taft sp. nov. Fig. 5.

Cells small, as broad as long, constriction deep, sinus opening wide; semicells roughly elliptic, apex depressed, margin granulate, lower margin rounded, smooth, slightly concave near the angles, angles truncate, each with a sharp, stout spine pointing downward, surface granulate, granules small and in series across the sides and top of the angles; vertical view triangular, sides slightly concave, wall granulate, granules in series across the angles, granules at center scattered.

L. 31–34μ, w. 31–33μ, isth. 9–10μ.

Boundry Butte, North Dakota.

The depressed semicells, absence of spines on the cell wall, and the truncate apices of the angles distinguish this species from *St. arnellii* var. *spiniferum* W. & W. (West & Carter, 1923). The type of granulation, the absence of verrucae, and the truncate angles separate it from *St. oxyrhynchum* Roy & Biss. (Roy & Biss, 1886).

Staurastrum hirsutum Bréb.
Staurastrum punctulatum forma? Boldt. (Boldt. 1888).
Hyalotheca dissiliens (Sm.) Bréb.
Hyalotheca mucosa (Mert.) Ehr.
Desmidium aptogonum var. *aculius* Nordst.
Desmidium swartzii Ag.

Euglenophyta

Euglena pisciformis Klebs
Euglena sanguinea Ehr.
Phacus pleuronectes (Müll.) Duj.
Phacus triqueter (Ehr.) Duj.
Trachelomonas volvocina Ehr.

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